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A High-Velocity 7.62-mm (0.30-cal.) Gun System

by Donald J. Little

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14. ABSTRACT

The U.S. Army Research Laboratory (ARL) has many requirements to test projectiles in excess of their normal muzzle velocities or maximum powder loads, particularly to determine comparative ballistic performance. ARL's existing 7.62-mm (0.30-cal.) bore guns are not capable of launching the 7.62-mm (0.30-cal.) fragment-simulating projectile above 1350 m/s. Since testing requirements often exceed 1500 m/s, a custom chamber system was designed and successfully tested to fulfill this need.

15. SUBJECT TERMS

.30 caliber, high velocity, fragment-simulating projectile

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1. Introduction

The ballistic analysis of armor systems and armor materials against fragment threats often requires velocities above 1500 m/s. Four different mass and caliber fragment-simulating projectiles (FSP) are used for ballistic testing at the U.S. Army Research Laboratory (ARL): 5.56 mm (0.22 cal.), 7.62 mm (0.30 cal.), 12.7 mm (0.50 cal.), and 20 mm.[1] Chamber and bore combinations exist to achieve the needed velocities for 5.56-mm, 12.7-mm, and 20-mm FSPs. However, the maximum velocity achievable for the 7.62-mm (0.30-cal.) FSP using the standard Springfield chamber, shown in figures 1 and 2, is limited to around 1400 m/s, about 100–150 m/s short of the test requirements. To reach these velocities using the current Springfield chamber, the case must be completely filled with propellant and obvious signs of over-pressure occur. Trying to reach these high velocities using standard equipment causes undo wear on the gun and breech and results in an unsafe operating method. ARL overcame this limitation by designing a new larger 7.62-mm chamber and the result is a safe, easy-to-use test fixture that exceeds current velocity requirements.

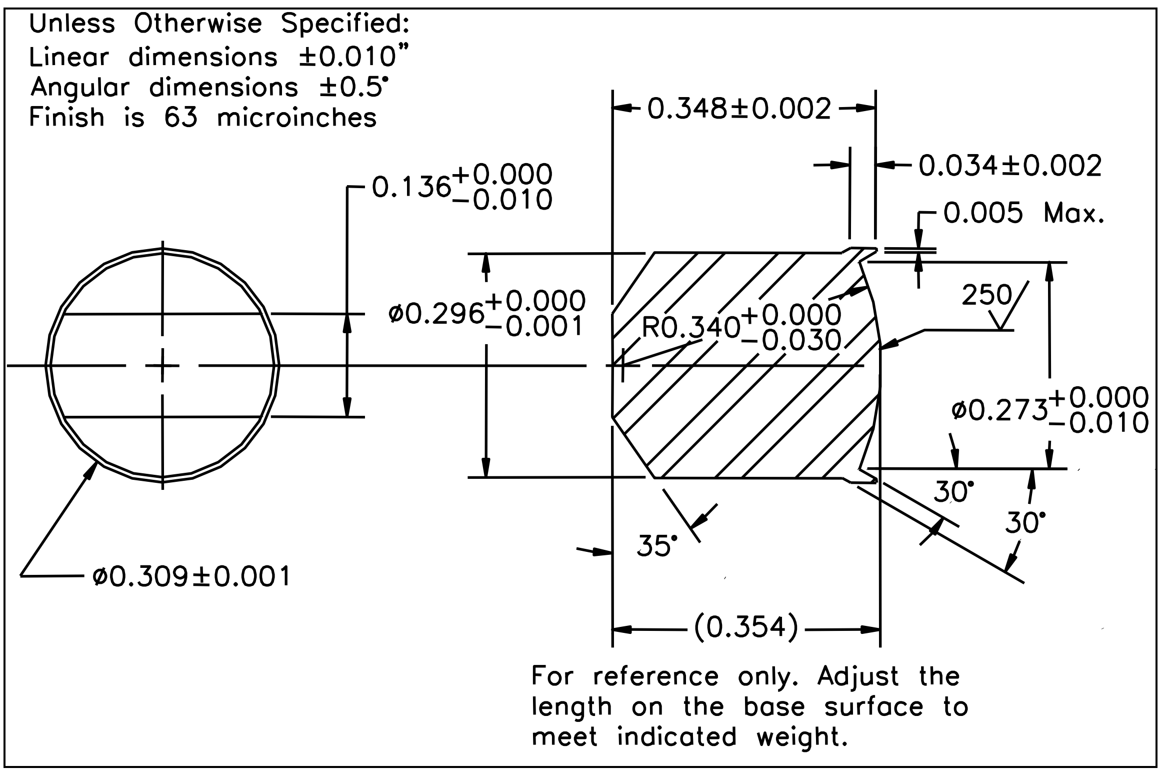

Figure 1. The 7.62-mm (0.30-cal.) fragment-simulating projectile.

[1]MIL-DTL-4659313. *Detail Specification: Projectile, Calibers 0.22, 0.30, 0.50 and 20 mm Fragment-Simulating*. U.S. Army Research Laboratory: Aberdeen Proving Ground, MD, 6 July 2006.

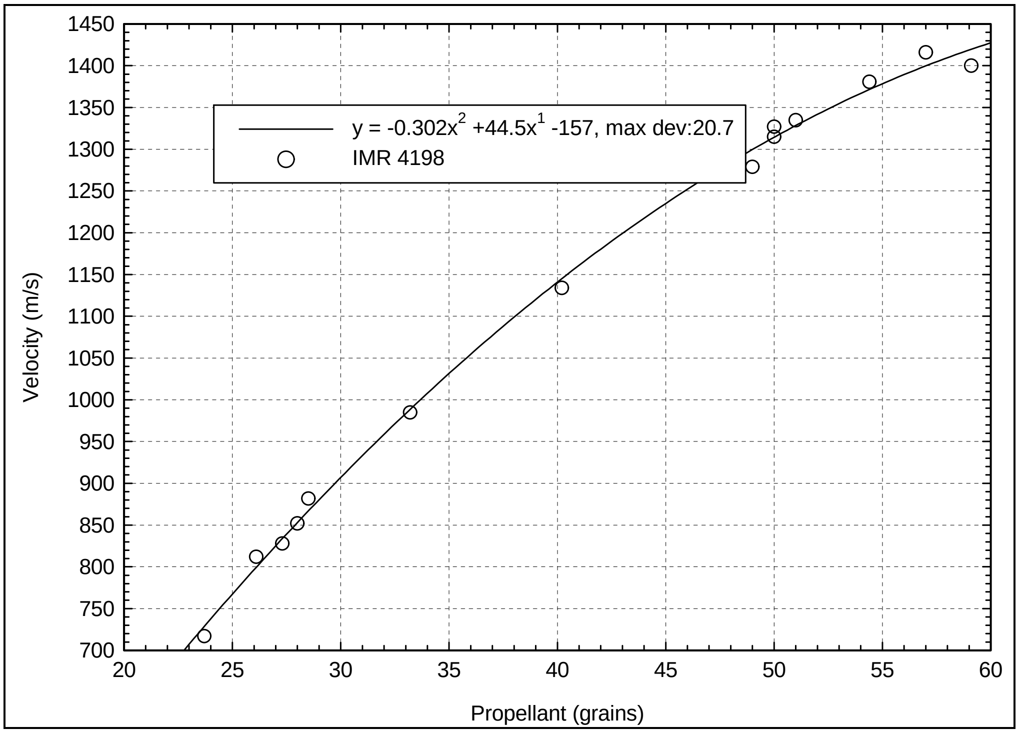

Figure 2. Propellant-loading curve for the 7.62-mm (0.30-cal.) FSP launched from 0.30-06 barrel "B."

2. Approach

A custom screw-on chamber was designed and fabricated to allow for a larger capacity case that increased the propellant charge 2.5 times over that of the Springfield case. The outside diameter of the chamber was threaded to accept the standard heavy machine gun percussion initiation breech. The barrel and internal diameter of chamber have a 16-TPI thread machined in them to mate the two pieces together, shown in figures 3–5. For the initial experiments, cases were made from 4340 tool steel and a standard brass alloy; both variations held up well to the pressures and showed no visible signs of stress or pressure deformation. Cases to fit this chamber were made from simple 1-in outside diameter × 2-in-long straight cylinders, shown in figure 6. Internally, three different diameters were machined into the cases (0.550, 0.650, and 0.750 in) to allow for increasing volumes of propellant. Due to the increased case volume and propellant charge, a slightly more energetic primer was required and the cases were machined to accept 12.7-mm (0.50-cal.) browning machine gun (BMG) primers. The chamber depth was machined so a portion of the case extended out of the chamber. An extraction groove was machined in each case to allow for attachment of an extraction tool to aid in case removal after a shot. A custom removal tool, shown in figure 7, was designed to attach to the machined groove in each case and used a slide weight that could be thrust rearward to hammer the case free.

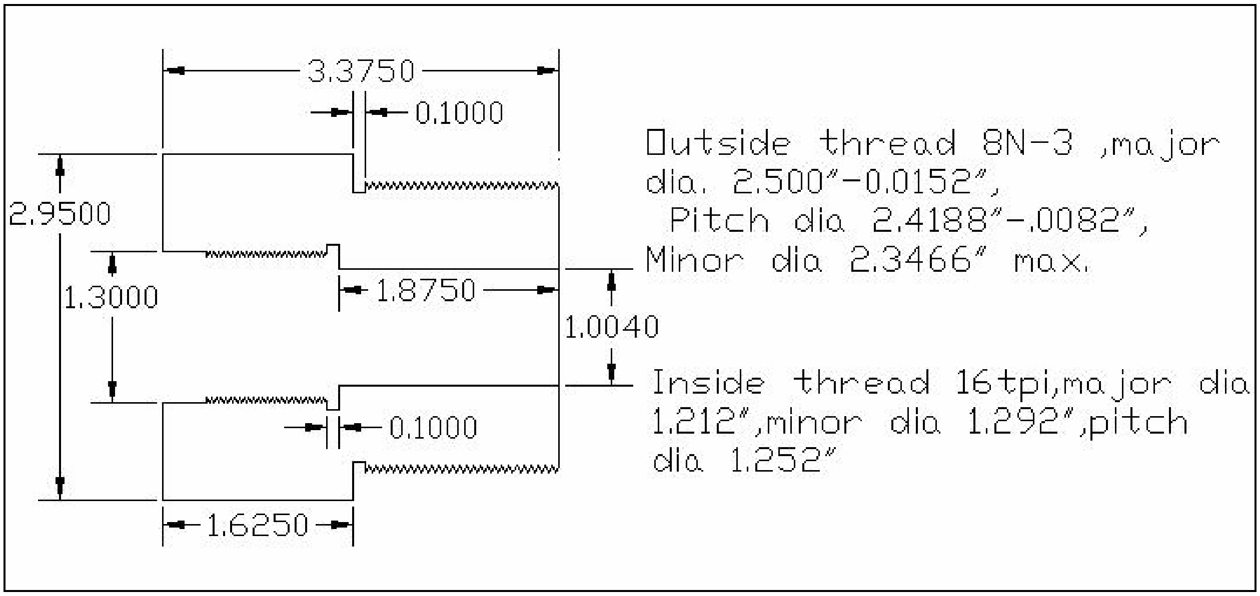

Figure 3. Side view of 7.62-mm (0.30-cal.) high-velocity, custom chamber.

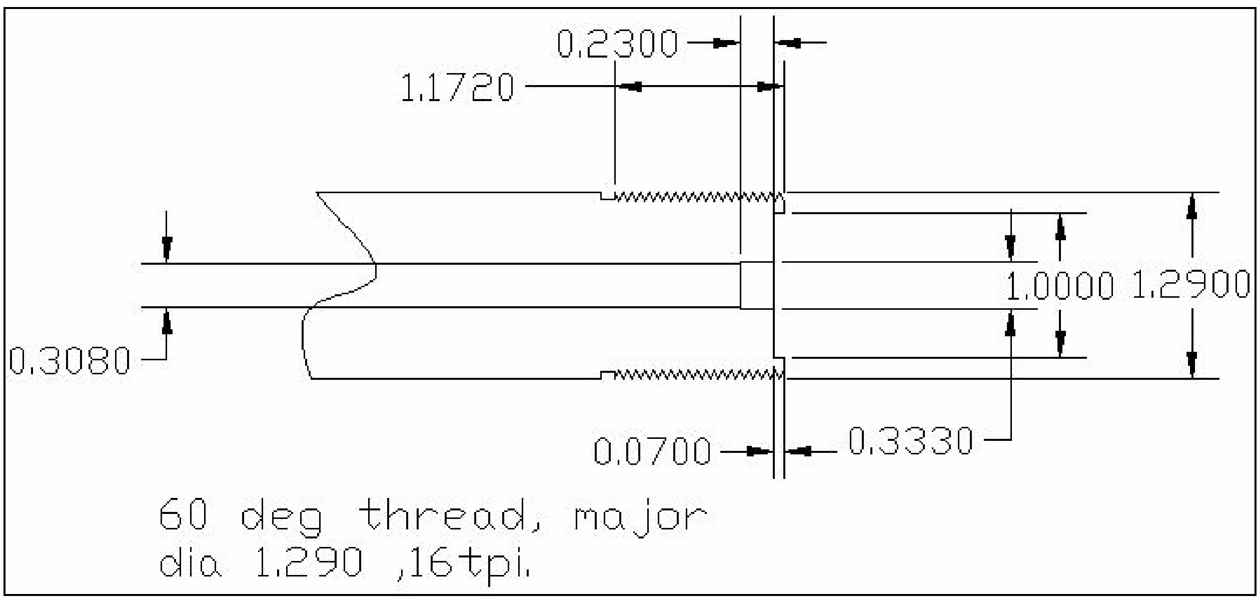

Figure 4. Modification to end of barrel blank to receive custom screw-on chamber.

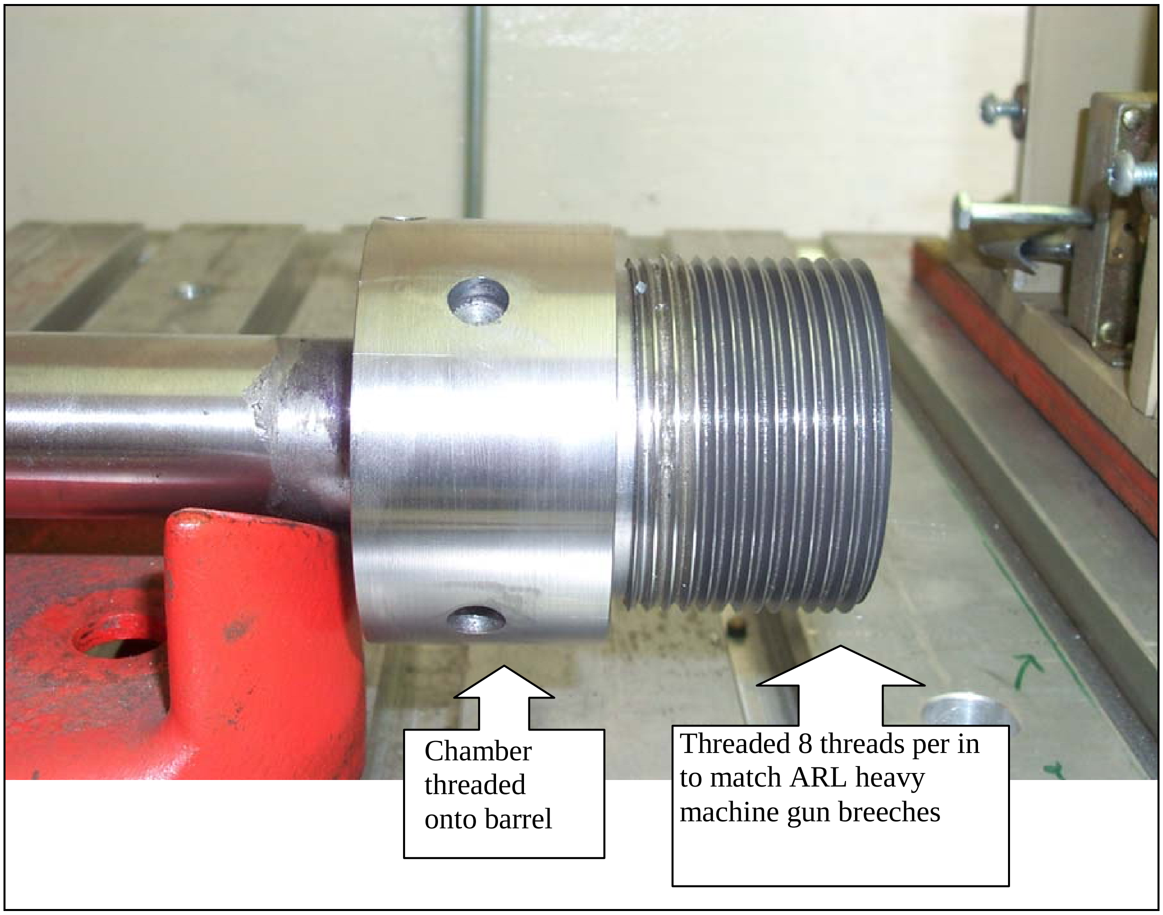

Figure 5. Photograph of custom chamber attached to barrel.

3. Experiments

Two types of propellants were chosen to do the experiments, IMR4350 and IMR4198. On the listed smokeless powder burn-rate chart of 107 powders, IMR4350 ranks no. 82 and IMR4198 ranks no. 51.[2] Maximum case capacities were calculated for each type of propellant and each different internal case volume. The baseline experiments started with the smallest internal volume case (0.550 in) and the slowest burn-rate propellant (IMR4350). The propellant load was increased in increments through each combination of case size and propellant type up to the maximum load for each, shown in table 1 and figure 8. The largest internal diameter case was not tested, since the velocity goal was achieved using 0.550 and 0.650 in internal diameter cases. The custom cases showed no signs of overpressure at the conclusion of testing (figure 9).

[2]Burn-rate data courtesy of Hodgdon Powder Company. www.hodgdon.com (accessed September 2006).

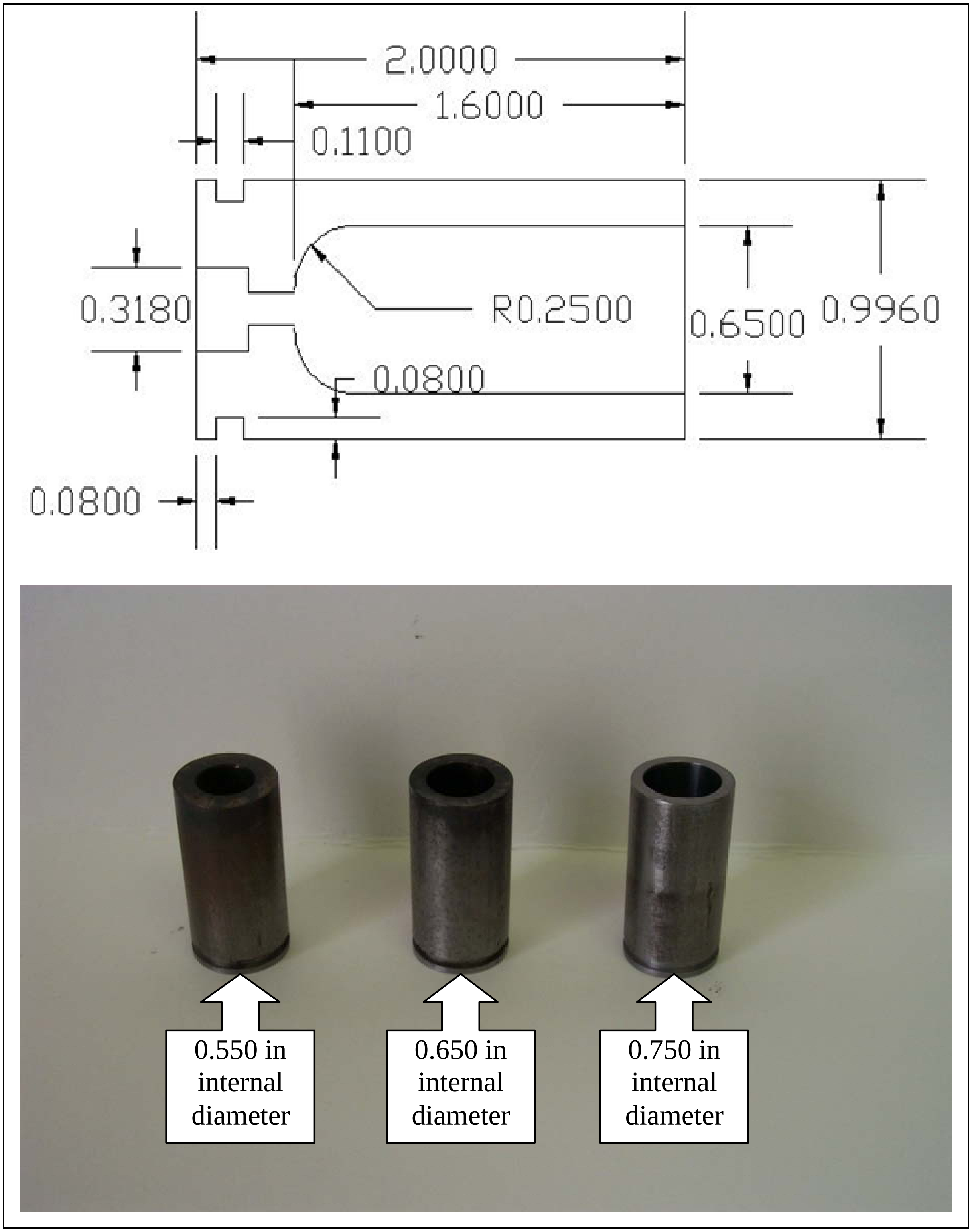

Figure 6. Side view and dimensions of 7.62-mm (0.30-cal.) FSP high-velocity custom case.

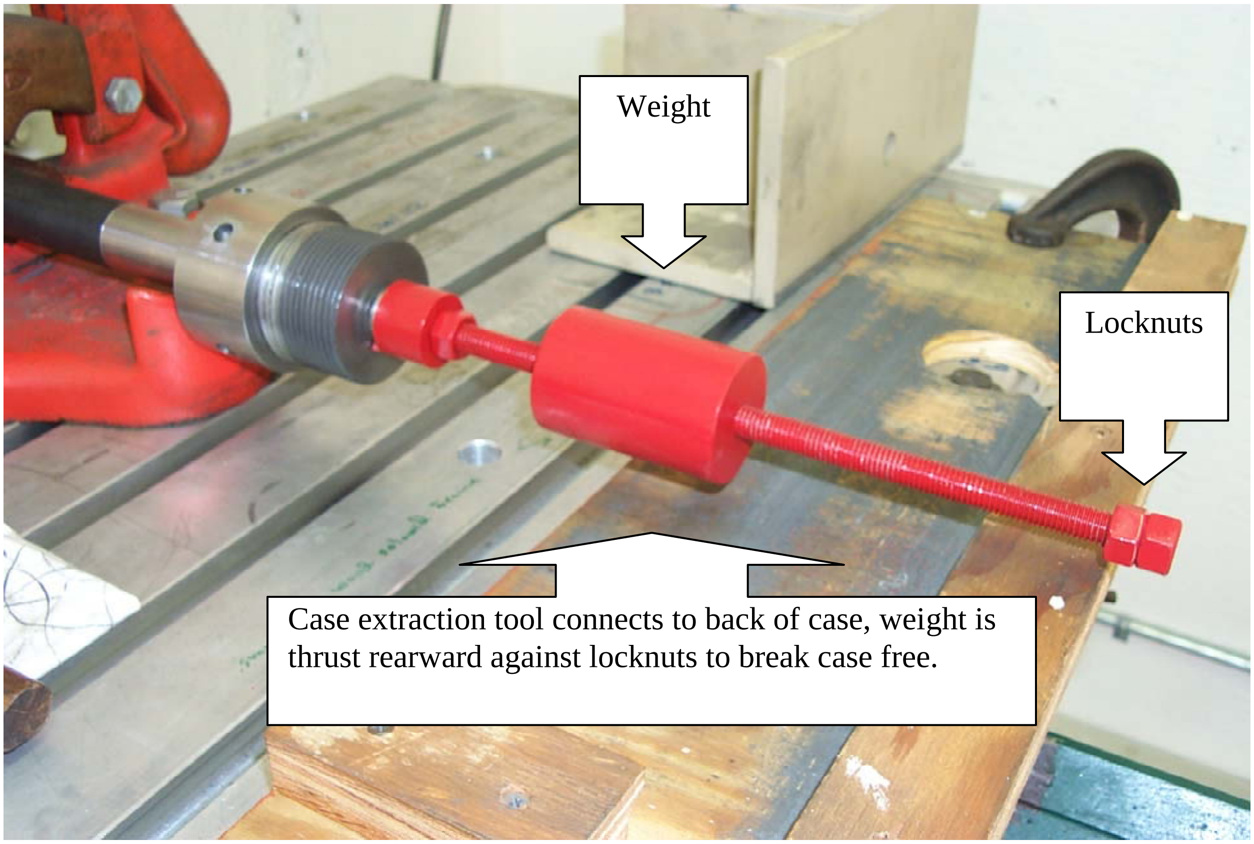

Figure 7. Custom case-extraction tool.

Table 1. Test results.

AMB Shot No.	Powder Weight (gr)	Velocity (ft/s)	Velocity (m/s)	Case Capacity
Powder Type IMR4198 Steel Case ID .550 in				
4788	70	5291	1613	Full case
4787	62	4831	1472	7/8 full
4785	52.5	4331	1320	3/4 full
4786	35	3186	971	1/2 full
Powder Type IMR4350 Steel Case ID .550 in				
4779	80	4651	1418	Full case
4778	74	4446	1355	7/8 full
4777	63.75	3892	1186	3/4 full
4776	42.5	2599	792	1/2 full
Powder Type IMR4350 Steel Case ID .650 in				
4783	110	4980	1518	Full case
4781	96.5	4549	1387	7/8 full
4780	83	3756	1145	3/4 full
4784	55	2700	823	1/2 full

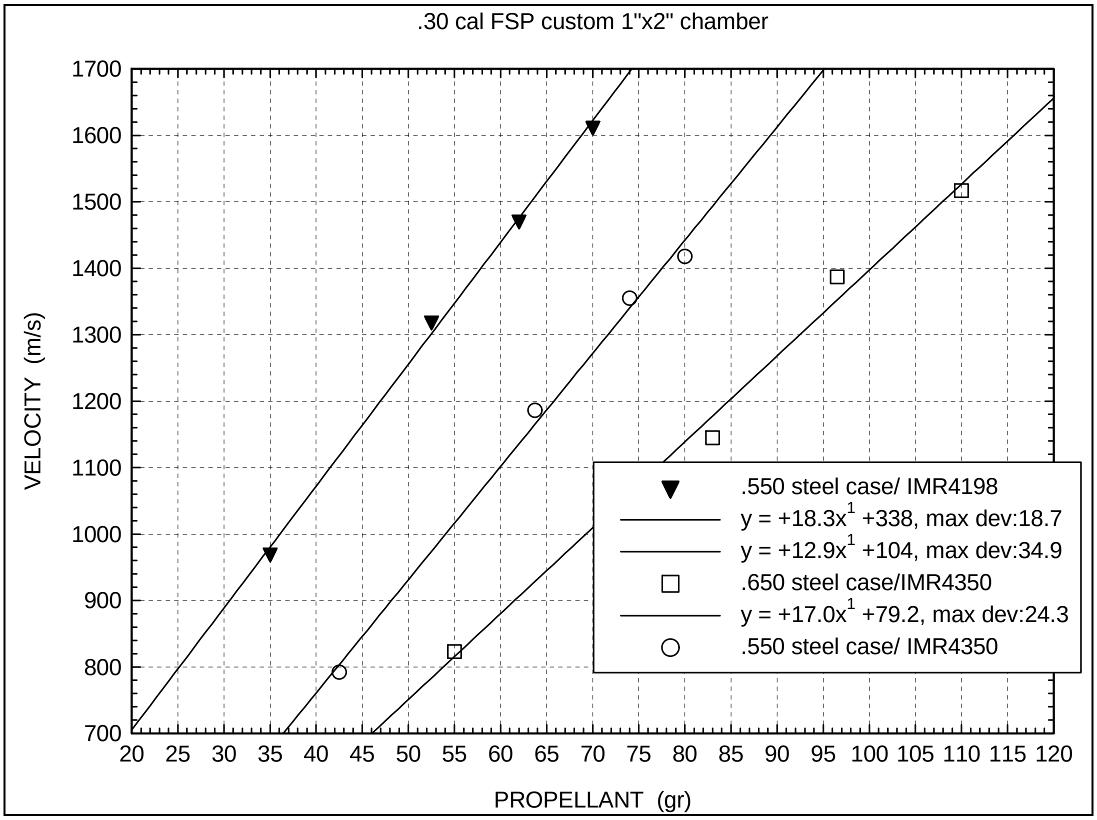

Figure 8. Propellant-loading curve for the 7.62-mm (0.30-cal.) FSP launched from the custom 1- × 2-in chamber.

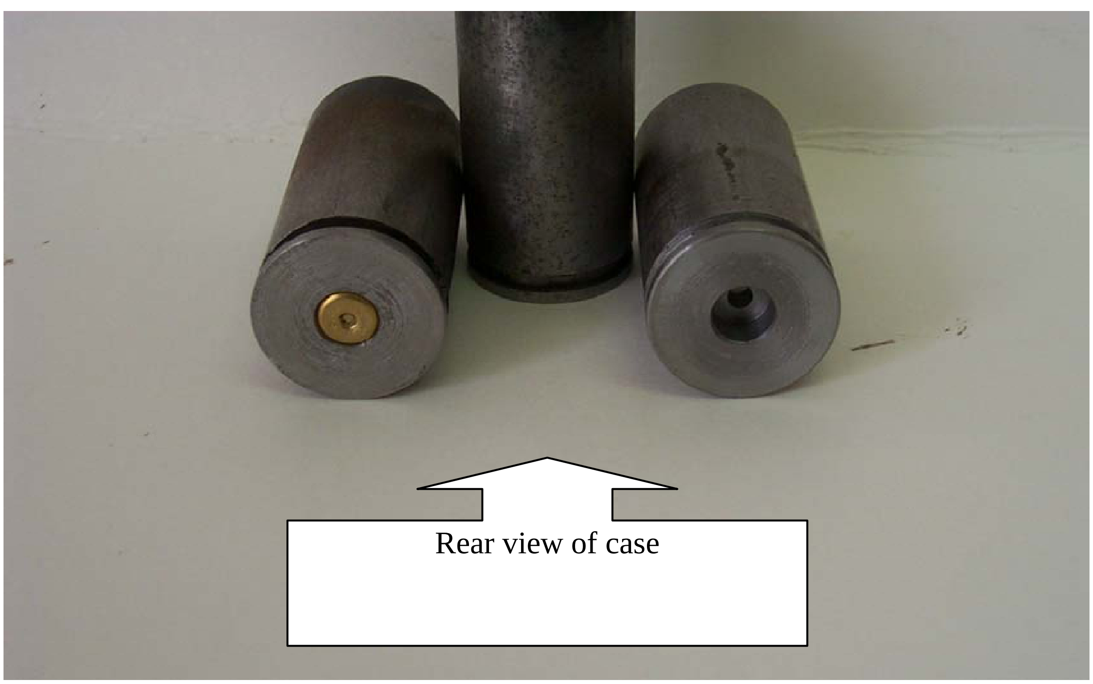

Figure 9. Rear view of custom cases at the conclusion of testing.

4. Conclusion

The required testing velocities were successfully achieved with each type of propellant. IMR 4350 required 40 gr more propellant than IMR4198 to reach the goal. At half-case capacity, the IMR4350 showed signs of incomplete propellant burn in the bore of the weapon. IMR 4198 demonstrated good burn characteristics at all capacities, showed no signs of overpressure in the case or primer area, and allowed ARL to reach our goal using substantially less propellant. Therefore, IMR4198 is the recommended propellant for this bore and chamber combination to reach the desired velocities. This chamber/propellant combination allows safe and repeatable testing of 7.62-mm (0.30-cal.) FSPs at higher velocities of interest than that currently available. These modified systems are now in use at ARL.

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